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POSITRON ANNIHILATION IN A LASER RADIATION FIELD

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ABSTRACT

An experiment is described in which positron annihilation in a NaCl crystal was observed in the presence of the radiation field of a laser. The decay constant of the long lifetime component in the lifetime spectrum was about twenty per cent larger in the presence of the field, than with the radiation field absent.

РЕЗЮМЕ

Описывается эксперимент, в котором наблюдалась аннигиляция позитронов в кристалле NaCl при наличии радиационного поля лазера. Показано, что постоянная распада долгоживущей компоненты во временном спектре аннигиляции при наличии поля лазера примерно на двадцать процентов больше, чем без облучения.

KIVONAT

Megfigyeltük a pozitronok szétsugárzását NaCl kristályban, lézersugárzás jelenlétében. Azt találtuk, hogy az időspektrum hosszu élettartamu komponensének bomlási állandóját a sugárzási tér mintegy husz százalékkal megnöveli.

Recent experiments strongly indicate that the long-lived component in the lifetime spectra of positrons in ionic crystals is due to A-center formation [1]. The A-center can be viewed as a positron localized in a positive ion vacancy under the influence of the Coulomb field acting within the crystal. Since the Coulomb field at the same time ensures a low electron density in the vacancy, the overlap between the electron and positron densities is reduced in a comparison with the case of the untrapped positrons and consequently the lifetime may be relatively long.

The properties of A-centers must be in many respects similar to those of F- and V-type color centers. However, the dynamical characteristics of A-centers cannot be studied through coloration of the crystal produced, because the centers are unstable and of low density. Nevertheless, one can hope instead to observe the variation of the lifetime τ_2 of the long component in the electromagnetic field of a laser. The variation of τ_2 as a function of the radiation frequency should contain the same information about the A-centers as absorption spectra about F- and V-centers.

The expected effect is a lowering of τ_2 under the influence of the radiation field without change in the lifetime of the short component. The reason for this is that the Coulomb forces in the crystal probably stabilize the overlap between positron and electron densities to a minimum, so that an external field can lead only to a greater overlap. On the

other hand, the short component is due to free annihilation of thermalized positrons for which there is no a priori correlation between positron and electron densities.

To estimate the order of magnitude of the variation of τ_2 we performed a set of measurements of positron lifetime spectra. Runs with and without irradiation followed each other in succession. A strongly quenched NaCl single crystal with a pronouced long component was used. The laser was of He-Ne type /6328 Å/ with a power of about 10 mW and a beam diameter of 3 mm.

The lifetimes were extracted from the spectra drawn in logarithmic scale, using ruler. A typical time spectrum is shown in Fig. 1. The lifetimes τ_2 obtained with the radiation field present were always lower than those obtained in the absence of the field. Averaging the results of all runs, the values $\tau_2 = 0.57 \pm 0.05$ nsec and $\tau_2 = 0.79 \pm 0.05$ nsec were obtained, with and without the field, respectively. The value of τ_1 was more uncertain but it seemed to be insensitive to the presence of the field. These results, however, are to be considered as preliminary. The measurements will be repeated and data handling improved.

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REFERENCES

[1] W.Brandt, Hsi Fong Waung and P.W.Levy: Phys.Rev.Lett. 26, 496 /1971/

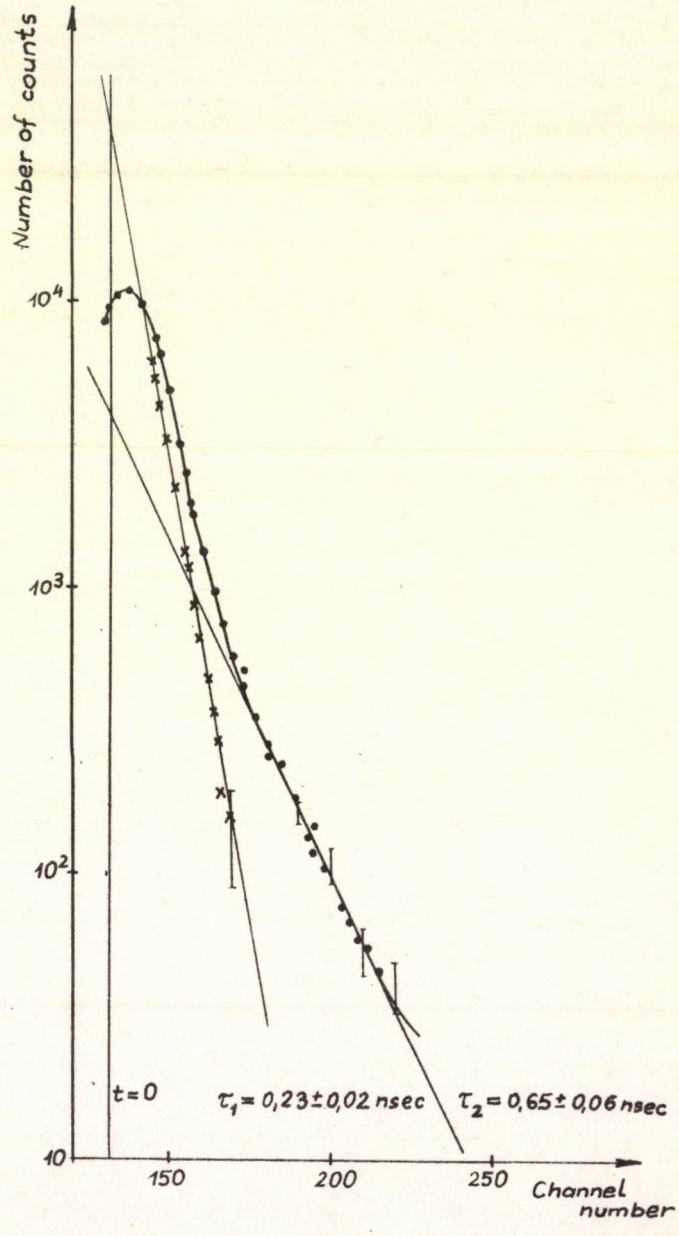
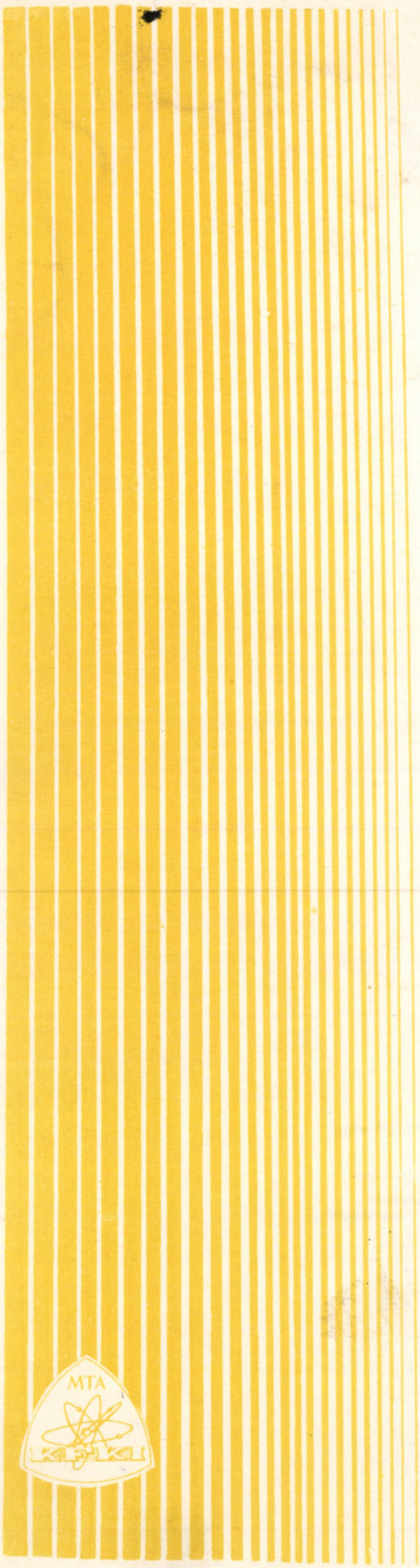

Number of counts
10^4
10^3
10^2
10
t=0
$\tau_1 = 0,23 \pm 0,02$ nsec
$\tau_2 = 0,65 \pm 0,06$ nsec
150
200
250
Channel number

Fig. 1



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Magfizikai Tudományos Tanácsának elnöke
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Nyelvi lektor: T. Wilkinson
Példányszám: 230 Törzsszám: 71-6169
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